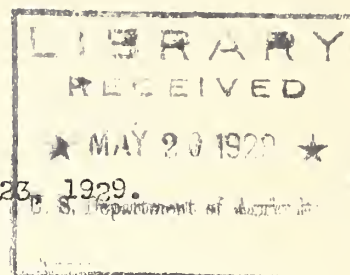


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United States Department of Agriculture
Bureau of Biological Survey
Washington, D.C.



March 23, 1929.

THE EFFECT OF POISONS USED IN RODENT CONTROL
ON GROUSE, PHEASANTS, AND QUAIL

The control of injurious rodents in the Western States by the use of poisons has at times caused considerable apprehension for the safety of grouse, pheasants, and quail on the part of persons interested in the conservation of these birds. As the functions of the Biological Survey have to do with both the conservation of game and all useful or harmless forms of wild life, as well as with the control of economically injurious species, it is evident that the Bureau would not recommend the general use of those poisons for rodent control that would be detrimental to game birds. There are some rodent poisons that may have ill effects on grouse, pheasants, and quail, but this is not the case with strychnine when it is employed in accordance with recommendations made by the Survey, and as a general rule the strychnine baits recommended by the Bureau are at present the ones used by farmers for the control of rodents.

The misleading statements circulated by some writers regarding the alleged fearful mortality among these birds from eating strychnine baits for rodent control have been disproved both by extensive field observations and by laboratory and field experiments in feeding strychnine-poisoned grain to the birds. Reports are attached on such investigations made by the Chief Game Guardian of the Province of Saskatchewan, Canada; and in this country by the Associated Sportsmen's Clubs of California, and by the Biological Survey. Observations and carefully conducted experiments have proved that gallinaceous birds, which include the various species of grouse, pheasants, and quail, as well as domestic chickens, possess a relative immunity from strychnine poisoning and that these birds are not likely to be harmed by eating rodent poison in which strychnine is used as the toxic agent in the proportion recommended by the Biological Survey and commonly used in the United States.

Paul G. Redington

Paul G. Redington.

Chief.



RECORDS OF POISON EXPERIMENTS IN DETERMINING THE EFFECTS OF GROUND
SQUIRREL POISONS ON CALIFORNIA VALLEY QUAIL AS CONDUCTED BY THE
ASSOCIATED SPORTSMEN'S CLUBS OF CALIFORNIA IN COOPERATION WITH
THE UNITED STATES BIOLOGICAL SURVEY AND THE CALIFORNIA FISH
AND GAME COMMISSION

September, 1925

For some time complaints have been made to those in the Western States conducting operations with poisoned grain against ground squirrels and other field rodents to the effect that quail are being greatly reduced in number through the distribution of this grain. Several tests had been made by the Biological Survey in different States showing that oats and barley poisoned with strychnine in accordance with its standard formulas would not kill quail, pheasants, or grouse. The United States Public Health Service has made similar tests and reached the same conclusion. Other poisons, such as phosphorus or arsenic, however, which are used to a limited extent in some commercial poisons and by individual ranchers, had not been tested. Investigations had been made and phosphorus placed under suspicion.

The Associated Sportsmen's Clubs of California became interested in the problem of the reduction in the number of quail and arranged to secure the quail for use in experiments with poisons through the State Fish and Game Commission, inviting the Commission and the Biological Survey to cooperate with them in conducting the tests. We were glad to take advantage of this opportunity to make the much desired tests. Representatives of the three organizations were present to observe the results. The members of the Associated Sportsmen's Clubs of California are specially to be commended for the faithful manner in which they have kept some member present to watch the pens both day and night, many sacrificing valuable time and business to keep their watch.

Representatives of the Survey were present during the day to attend to the feeding of the poisons and to watch and record results. A representative of the Fish and Game Commission was present, assisting with suggestions and noting results.

Dr. Frank Kolos, a member of the Associated Sportsmen's Clubs, tested the poisoned grains used and made examinations of the birds that died. George P. Gray, in charge of the Chemical Division of the State Department of Agriculture, cooperated by determining the quantity of poison carried by 100 kernels of the various poisoned grain mixtures used in the tests.

Locality of Experiments

J. P. Cuenin and E. R. Kaufman, representatives of the Associated Sportsmen's Clubs, arranged with John McLaren, superintendent of the Golden Gate Park, San Francisco, for space on the park grounds, and had seven pens built for the birds. Four of these were subdivided into four compartments each for individual birds. The larger pens were for reserve birds. For a few days after arrival the birds, which were brought in from the Sacramento Valley, suffered from the cooler temperature, some dying as a result. The weather soon became warmer and the birds were in good condition most of the time covered by the experiments. A few bad days occurred at the start and a few also at the end of the experiments.

Grains Used in Poisoning Squirrels

The grain recommended by the United States Biological Survey for use against the California "digger" ground squirrel is whole re-cleaned barley, and for use against the Oregon ground squirrel in the northeastern part of the State is whole oats. These grains have been generally used by those in charge of rodent control operations in the different counties. In a few cases wheat and hulled barley are used. In other States oats or rolled oats are chiefly used against field rodent pests.

Poisons Used in Rodent Control

The poison recommended and generally used in operations against field rodents is strychnine alkaloid. Strychnine sulphate is now rarely used. To a limited extent phosphorus, arsenic, and cyanide have been and are used for this purpose.

Distribution of Poisoned Grain

Poisoned grain bait used in controlling ground squirrels is usually well scattered about the burrows of the animals each bait averaging about a tablespoonful. With grains of average quality, in a tablespoonful of wheat there would be about 400 kernels, of hulled barley about the same number, of whole barley about 350, of oat groats about 680 and of whole oats about 300. It was found that the squirrels usually cleaned up most of these baits within two days and where infestation is heavy, within a few hours.

Feeding Capacity of Quail and Choice of Grains

Whole Barley.--Four quail kept in separate compartments were given 50, 100, 150, and 200 kernels of whole barley, respectively, without other feed, during a period of 24 hours. The bird given the 100 kernels ate 38 of them, but the others did not take a single kernel.

Other birds had whole barley together with other feed before them for several days and did not eat any.

Hulled Barley.--Two quail kept in separate compartments were given 50 and 100 kernels of hulled barley, respectively, during a period of 24 hours. The one fed the 50 kernels ate all of them, a few at a time, within 3 hours, but the other did not touch any of the grain given to it. They did not appear to relish the hulled barley, though they apparently preferred it to the whole barley.

Whole Oats.--One quail was fed 50 whole dry oat kernels, and during a period of 24 hours hulled and ate 15 of them. Oats soaked in water for a few minutes and then fed along with dry oats were eaten more readily than the dry oats. This was tried on several quail. Rolled oats were eaten more readily than the whole oats.

Hulled Oats, or Oat Groats.--Hulled oats were greedily eaten by the quail. A capacity test run showed that 250 kernels constituted the maximum quantity taken in 24 hours; 200 comprised the average daily feed.

Wheat.--Wheat was readily eaten by the quail. Capacity tests made with several of the birds showed that 150 kernels constituted about the maximum for a period of 24 hours. The average feed at any one time was 50 kernels of average size wheat, although considerably more grain might be placed before them.

When the quail were given a mixture containing all these grains it was observed that they would at once pick out the oat groats and wheat, not touching the other grain as long as these two grains were present. When these were consumed they would take the others in the following order: Hulled barley, oats, and whole barley. They had to be starved into eating the latter grains. In order to get a real test of the quantity of strychnine a quail could take we had to use poisoned wheat.

Record of Poison Tests on Quail *

Pen No. 1

Compartment No. 1.--Two young birds, male and female, were fed, at 10 a.m. on the 13th of the month, 50 kernels of poisoned whole barley of Standard 1-16 (1 ounce of strychnine to 16 quarts of grain) carrying 0.08 grain strychnine. By 10:30 a.m. on the 14th they had taken 22 kernels, and by 4 p.m. of the same day the remainder. They were then given some clean wheat, which they immediately ate. On the 15th they were again given clean grain. At 4:20 p.m. on the 16th, 200 kernels of poisoned whole barley, 1 to 8, carrying 0.56 grain strychnine were fed. Very little of it was eaten until the forenoon of the 17th, when hunger forced the birds to eat it a little at a time. By 5 p.m. all of the grain had been eaten. When released on the 25th the birds showed no ill effects from the poison.

* In addition to the grains fed, all birds were given some lettuce and fresh water daily.

Compartment No. 2.--A young male and a female, the latter droopy with ruffled feathers indicating that it was sick with a cold, at 10 a.m. on the 13th were given 50 kernels of poisoned whole barley, (1 to 8), carrying 0.14 grain strychnine. On the 14th at 10:30 a.m., 37 kernels had been eaten, and by 3 p.m. all were consumed. The female gradually grew worse during the day and died in the night. Doctor Kolos, who examined the bird, reported death was due to cold. The male showed no ill effects from the poison.

Compartment No. 3.--An adult female was fed at 10 a.m. on the 14th, 100 kernels of commercial poisoned wheat (1 to 12), carrying 0.158 grain of strychnine. By 5 p.m. about half was consumed, and by 9 a.m. on the following morning all had been taken, at which time the bird was given a little clean wheat. At 10 a.m. on the 18th, she was again given 100 kernels of the same grain which were all eaten by 2:30 p.m., after which she was given clean grain, and showed no ill effects by the 25th.

Compartment No. 4.-- One bird was fed clean grains as a check until the 25th, when it was taken to Berkeley and fed for three days, beginning on the 27th, at 8 a.m. and again at 4 p.m., 10 kernels of a county poisoned wheat (1 to 12) and 40 kernels of clean wheat, and then for two more days, at the same hours, 15 kernels of the poisoned wheat and 50 kernels of clean wheat. The bird showed no ill effects from the poison.

Pen No. 4

Compartment No. 1.-- An adult male and a female were fed on the 13th at 2 p.m. a commercial poisoned mixture (1 to 12), consisting of 50 kernels of whole barley, 50 kernels of wheat, and 5 raisins and carrying 0.16 grain of strychnine. The female was observed to eat 38 kernels of wheat during the first half hour, and at the end of an hour both of them had eaten the wheat, but no barley or raisins were touched that day. At 10:30 a.m. on the following day 19 kernels of barley and two raisins were taken. The male bird was then removed to another compartment, and the female was given 100 kernels of wheat from the same commercial poison, which she had all eaten at 3 p.m. On the next day she was given 150 kernels of wheat of the same poison, which she ate during the day. On the 16th and thereafter she was fed clean grain, and showed no ill effects by the 25th. In the three days she had taken about 1/2 grain of strychnine, a quantity sufficient to kill 20 squirrels.

Compartment No. 2.-- Bird fed clean grain only.

Compartment No. 3.-- An adult male was fed on the 15th at 10:30 a.m. 150 kernels of a county poisoned wheat carrying 0.192 grain of strychnine, no other feed being present. By 10 a.m. on the 16th it had eaten only two kernels; when 50 kernels of clean wheat were given

the bird it readily consumed them, indicating a marked discrimination against the poisoned grain. By 4 p.m. the bird had eaten 68 more kernels of the poisoned wheat. The next day it ate 70 more, and by the 18th had eaten all of it being forced by hunger to do so. It experienced no apparent ill effects by the 25th.

Compartment No. 4.--An adult male was fed on the 16th at 10 a.m. 150 kernels of the same poisoned wheat that was given to the bird in compartment No. 3. This bird did not delay so long in eating the grain, having taken all of it by 5 p.m. On the next and subsequent days to the 25th it was fed clean grain and showed no ill effects of the poison.

Pen No. 3

Compartment No. 1.--An adult male on the 16th at 3 p.m. was fed 25 kernels of oats and 5 kernels of wheat, carrying 0.2 grain of phosphorus. It hesitated somewhat about eating the oats, but being hungry finally ate all including the hulls. By 3:45 p.m. it began to show symptoms of sickness; at 4:20 it became drowsy, opening and closing eyes, and appearing less and less active until 5 p.m. when it turned a somersault forward. It lay quiet for three minutes, then had a severe convulsion and died a minute later at 5:04 p.m.; 0.20 grain of phosphorus killed the bird in about 1-1/2 hours from the time it ate the oats.

Compartment No. 2.--An adult female on the 16th at 3 p.m. was fed 25 kernels of wheat carrying 0.144 grain of phosphorus. The bird picked up and dropped the kernels many times before swallowing a kernel. By 4 p.m. it had eaten only 8 kernels and no more had been taken by 5 p.m., when the remaining 17 were removed. It began to show effects of the poison at 4:45 p.m., and gradually grew quieter and sleepier until 6 p.m., when it had a convulsion and died at 6:05 p.m.; 0.046 grain of phosphorus thus killed the bird in about 2-1/2 hours.

Compartment No. 3.--An adult male on the 17th, at 10:15 a.m., was fed 5 kernels of oats, carrying 0.04 grain of phosphorus. It finished eating them by 11 a.m., and became sick at noon. The first light convulsion occurred at 1:30 p.m., and was followed by several others. The bird kept stretching its neck and twisting its head from side to side, and died at 2:15 p.m.; 0.04 grain of phosphorus killed the quail in about 3-1/2 hours.

On the 18th another quail, an adult female, was put in this compartment and was given 100 kernels of oat groats, carrying about 0.025 grain of Swartz's white arsenic. All the grain was eaten in a few minutes. The bird began to show drowsiness at about 12 m., which gradually increased until 1:30 p.m., when it sat down. It remained in this position until 2:20 p.m., when it fell over on its side and twisted its head about similar to the birds given phosphorus. It died at 2:36 p.m.

0.25 grain of arsenic killed it in about 4-1/2 hours. Arsenic is thus seen to be not so toxic to quail as is phosphorus.

Compartment No. 4.--An adult male on the 16th, at 3:30 p.m., was fed 50 kernels of wheat and 50 kernels of barley from a poisoned grain manufactured commercially. It was old material and the active poison is not known. At 3:30 p.m. on the following day with no other grain present the bird had not eaten any of it. This was then removed and 50 kernels of the wheat with some clean wheat was fed. The clean grain was eaten on the 18th and 19th, but very little of the poisoned wheat was taken. On the 20th at 3 p.m., 150 kernels of wheat from a fresh supply of this same commercial poison, which was labeled strychnine as the active poison, was given with no clean grain present. About half of these were consumed by 4 p.m., and the remainder by 2 p.m. on the following day. The bird shows no ill effects.

Pen No. 2

Compartment No. 1.--A young female on the 13th at 9:45 a.m. was fed 25 kernels of hulled barley, carrying about 0.02 grain of thallium sulphate. No other grain was present. By 11 a.m. on the following day only one kernel was taken. This grain was then removed and the bird given clean grain. On the 15th at 4:30 p.m. the bird was given 50 kernels of oat groats, carrying 0.133 grain of thallium which it ate at once. It was fed clean grain on the 16th and 17th. By 3 p.m. on the 18th it showed no ill effects so it was given 100 kernels more of the same poison, which it had eaten by 5 p.m. On the following morning at 6 a.m. the bird was active but was extending its neck and gasping for breath at fairly regular intervals--the usual symptom of thallium poisoning. It did not eat during the day and gradually grew weaker without any apparent pain, and died at 3:25 p.m.

Compartment No. 2.--A young male, refused to eat the poisoned hulled barley fed to it similar to the bird in Compartment 1. On the 16th, at 3:45 p.m., it was given 75 kernels of the oat groats preparation, carrying 0.207 grain of thallium sulphate, which it ate within 45 minutes. On the 18th and 19th the bird was drowsy and did not eat normally, but on the 20th it began to improve and was normal on the following day, and remained so until the 29th. On the 30 a test was begun to determine the accumulative action of thallium sulphate. The bird was given 25 kernels of the oat groats carrying 0.069 grain of thallium sulphate and 75 kernels of clean oat groats at 8 a.m. and like quantities repeated at 4 p.m. of the same day and at 8 a.m. on October 1. It died on October 1 during the night.

Compartment No. 3.--A young female on the 14th at 10:15 a.m. was fed 100 kernels of oat groats, carrying 0.277 grain of thallium sulphate. It had eaten half of the oats by noon and all by 3 p.m., and was given a little clean grain in the evening, which it ate. Bird was lively at

midnight but quite sick at 6 a.m. It died at 10:30 a.m., about 24 hours from the time it began eating the poison.

Compartment No. 4.--The test given the bird in Compartment No. 3 was repeated with an adult female on the 17th at 4 p.m. The bird ate the poisoned grain at once. It was normal on the 18th. Fed clean grain on the 19th it ate the grain but was less active and not quite normal. At 8 a.m. on the 20th the bird was very sick, dying an hour later. The same quantity of poison as that given the young female in Compartment No. 3 killed this adult female in 65 hours.

Compartment No. 1.--A new bird, an adult male, was put in this compartment and fed 10 kernels of a commercial wheat preparation, carrying 0.02 grain of phosphorus, on the 22nd at 3 p.m. It ate the grain at once, and had a convulsion at 7:45 p.m., dying at 8:15 p.m.

These tests corroborate previous experiments made with strychnine on quail. The nine different birds fed poisoned grain ate from 2 to 150 kernels of wheat a day, and as much as 300 kernels during three consecutive days with and without clean grain and were not affected; also birds fed 50 kernels of wheat morning and evening, 10 of which were poisoned, for 5 consecutive days showed no ill effects.

The experiments have left no doubt about phosphorus, since only five kernels killed a quail in 4-1/2 hours. There is great danger to game birds in poisoning operations even if whole barley is used, for though the tests showed they do not take barley or whole oats readily, they are likely to pick up from 5 to 20 kernels of the grain in many localities, which would be fatal. Phosphorus is very toxic to quail and its use should be prohibited.

Arsenic and thallium sulphate are less toxic than phosphorus, but as they may have to be used on hulled grain or rolled grain to obtain the most efficient results against ground squirrels, there would be considerable danger to game birds in the distribution of such grains for squirrels or other field rodents. It is believed that phosphorus, arsenic, and thallium should not be used in poisoning operations in which baits would be exposed to any animal other than those against which the control operations are directed. They could be used in rat and field-mouse control where the distribution is confined.

The experiments show also that young quail are not affected any more by strychnine than adults. There is some indication, however, that thallium sulphate may kill the young more quickly than the adults. More tests will have to be made in order to determine definitely this latter point.

Respectfully submitted,

F. E. GARLOUGH

Assistant Biologist.

JOSEPH KEYES,

Leader Rodent Control.

AN EXPERIMENT TO DETERMINE THE EFFECT (IF ANY) OF
FEEDING STRYCHNINE POISONED GRAIN TO GROUSE

January, 1923.

Tuesday, January 9, 1923.--Four grouse were received from Powder River County from a rancher near Ashland, Mont., on a tributary of the Tongue River. There he caught these birds with a figure-4 trap. He shipped them on January 6 and they arrived here January 9 at noon. In the crate were supplied corn and wheat. At 4:30 p.m., while being transferred to a larger coop, one bird escaped and flew into a glass door, breaking the glass and continuing its flight into the country, apparently unharmed. The birds appeared to be sharp-tailed grouse (*Pedioetes phasianellus campestris*) and were in good condition. They were fed wheat and oats and given water and left for the night in a pen 6 by 3 feet in size.

Wednesday, January 10.--The pen was divided into three sections with a bird in each section. Bird No. 1, apparently a cock and seemingly older than the other two, was used as the "check". This bird was by far the most restless and fought the screen a good share of the time. No. 2 was somewhat restless, while No. 3 was quite content and did not fight the screen. All food was removed in the morning. At 2 p.m. each bird was given 50 kernels of clean wheat and oats and 6 kernels of corn. The corn and wheat were eaten at once. They did not relish the oats. At 4 p.m. Nos. 2 and 3 had eaten all the oats. The birds seemed to be quite tame. They were not fed again until next day.

Thursday, January 11.--The birds were not given any feed in the morning. No. 1 had oats left. At 4 p.m. No. 1 was fed 150 grains of clean oats. No. 2 was fed 150 grains of Richardson's ground squirrel bait and No. 3 was given 300 grains of prairie-dog bait. These quantities are equal to the quantities of bait recommended for these rodents and are equivalent to a teaspoonful and a tablespoonful respectively.

Bird No. 2 ate the 150 oats at once, readily. Given 150 additional kernels, it ate them at intervals. At 4:10 most of these kernels were eaten and 150 more were given. By 4:30 the oats were all eaten (450 kernels).

Bird No. 3 did not attack the oats so greedily and ate about one-half of the 300 kernels at first. It ate the last half at intervals, apparently not relishing them. At 4:30 p.m. No. 3 had 65 grains left. At 5 p.m., all birds seemed to be normal, and if the poisoned grain fed them had any harmful effect it was not apparent.

Friday, January 12.--No. 1, the check bird, was fed 200 clean oats in addition to some remaining from the day before. This bird did not seem to care for oats and spent most of its time fighting the screen in attempts to get out.

No. 2 was given 150 more of poisoned grain at 8:30 a.m. At 1:30 p.m. the bird had eaten only 14 of these. The remainder was thrown out, and a fresh bait of 150 kernels was given.

No. 3 still had the 65 remaining oats. These were thrown out and a fresh bait of 300 poisoned oats given at 8:30 a.m. By 1:30 p.m. No. 3 had eaten 35 grains; the rest of the bait was thrown out and a new bait of 300 fed.

The birds seemed to be hungry but did not like the oats. They were all active and showed no ill effects of eating poison.

Saturday, January 13.--At 9 a.m. No. 1 still had oats and ate few or none. No. 2 had 60 oats left and was not fed a new bait; by 5 p.m. it had eaten these and was given 36 more. At 9 a.m. No. 3 had 225 left. These were thrown out and a new bait of 100 grains given; at 5 p.m. it had 30 of the 100 left and was given 35 more.

The birds were left for the day. They were apparently unaffected by eating the poisoned oats.

Sunday, January 14.--All birds are active and hungry at 8:30 a.m. The check bird had 150 oats left. No. 2 had 22 left. No. 3 had 65 grains left and had therefore eaten none since the day before.

It was decided that the birds could not be killed by being fed poisoned oats, they having had practically all they wanted since the experiment started. The oats were all removed and each given 3 tablespoonfuls of clean wheat. The wheat runs 550 grains to the spoonful. They started eating the wheat greedily.

No. 1 ate the least. No. 2 ate more and No. 3 the most, about one-third of it. Their appetites seemed to be satisfied with these quantities. Although No. 1, the check bird, was the most restless, it would take grain out of the hand. No. 2 ate grain readily out of the hand.

Monday, January 15.--At 8:30 a.m. No. 1 had eaten three-fourths of the wheat and by 11 a.m. had only a teaspoonful left. No. 2 had 30 kernels of wheat left, which were eaten within a few minutes. No. 3 had 200 kernels left, which it cleaned up by 11 a.m. The above was all clean wheat.

It was believed that the grouse did not relish oats, so in order

to get them to take more poison it was decided to try them on some strychnine poisoned wheat, which was prepared at about the same strength as for prairie-dog poison.

At 2 p.m. No. 2 was given one-half tablespoonful of poisoned wheat, which it ate greedily, most of it out of the hand. It was given the other half at once and ate about one-half of it rapidly and then seemed satisfied and rested contentedly.

No. 3 was fed one-half tablespoonful of the same wheat. It ate one-half of it but not greedily. Seemed satisfied and contented. The wheat runs 550 grains per tablespoonful. The birds showed no symptoms of poisoning and were left for the day.

Tuesday, January 16.--At 9 a.m. No. 1 was fed a tablespoonful of clean wheat, which it ate greedily at once. At noon it ate another spoonful rapidly, at 3:30 another, and at 4:30 another, making 4 tablespoonfuls in all, or about 2,200 kernels.

At noon the 150 kernels of wheat remaining from the previous day's feed were removed from bird No. 2 and another tablespoonful of poisoned wheat was given.

No. 3 had eaten all of the previous day's bait by noon and was fed another tablespoonful.

Wednesday, January 17.--At 9 a.m. No. 1 was given a tablespoonful of clean wheat, which it ate at once. It was given a few clean oats but did not eat them. Another tablespoonful of clean wheat was given. No. 2 had one-half of the last bait left. This was thrown out and one-half tablespoonful of new poisoned wheat given. The bird did not care for this.

No. 3 had two-thirds of the last bait left. This was thrown out and another one-half spoonful given. The birds seemed to get "tired" of the poisoned wheat, while the check bird consumed large quantities of clean wheat.

Thursday, January 18.--At 9 a.m. No. 1 bird had no wheat left. It was given a tablespoonful of poisoned wheat of which he ate about one-half and then started "playing" with the remainder, picking up the kernels and casting them aside. The poisoned wheat was removed and replaced with a tablespoonful of clean wheat. This it went at greedily, eating all of it at once. Another tablespoonful was given. By 3:30 p.m. it had eaten most of this feed and was given the third tablespoonful of clean wheat. It ate most of this in a short time and was given a fourth tablespoonful of which it ate but very little up to 4 o'clock.

Bird No. 2 had practically all of the previous day's last bait left at 9 a.m. This was thrown out and the bird was given a new feed of a tablespoonful of poisoned wheat. It probably ate a few kernels but picked up and ejected quite a number. The poisoned wheat was removed, and the bird was fed a tablespoonful of clean wheat. This was eaten greedily. Another tablespoonful was given which was gone by 3:30. It ate all of a third tablespoonful and was given a fourth, most of which was eaten by 5 o'clock.

Bird No. 3 at 9 o'clock had 50 kernels of yesterday's last feed left. This was thrown out and it was given a fresh tablespoonful of poisoned wheat just as was done with Nos. 1 and 2. It ate but a few kernels. All poisoned grain was removed and a tablespoonful of clean wheat given. This was eaten at once followed by a second and then a third tablespoonful at 3:30. The second and most of the third spoonfuls were eaten readily and a fourth tablespoonful was fed of which she ate but little.

It will be noted that all three of these birds were fed exactly alike. The way they reacted toward the poisoned wheat as compared with the clean wheat indicates that there is something objectionable to the former. Although the poisoned wheat is dull and rather musty looking, on account of treatment, it is believed that the bitter taste of the strychnine is the cause for objection shown by the birds.

Friday, January 19.---At 9 a.m. bird No. 1 had one-half teaspoonful of wheat left, bird No. 2 had eaten all, and bird No. 3 had one-half teaspoonful left. The experiment being completed, the birds, apparently in the best of condition, were removed to a large outdoor inclosure containing some Chinese pheasants and doves. They were under the care of the poultry department and were fed ordinary mixed grain along with the pheasants and doves.

Mr. Otto Stephi, Junior Biologist, was in charge of this experiment.

(Signed) A. E. OMAN
Biological Assistant
District Leader.

EXPERIMENTS TO DETERMINE EFFECT OF POISONED GRAIN ON CHINESE PHEASANTS

January, 1922

With a view to determining the effect on the introduced Chinese pheasant of poisoned grain distributed for ground squirrels, a number of tests were made with birds secured from the King County game farm, at Snoqualmie, Wash. Clean, whole oats treated with poisoned flour paste were used throughout the experiments. The grain was prepared according to the formula and directions followed in mixing poisoned bait for the Columbia ground squirrel, which contains one ounce of strychnine alkaloid to every 12 quarts of oats.

The pheasants were undergrown birds about five or six months old. On arrival at the Experiment Station they were confined in a netting inclosure and fed on a mixture of grains such as is used for scratch food in the poultry department. Each bird, in turn, was transferred to a smaller coop for trial with the poisoned grain. Fresh water was accessible to them at all times. Results of the experiments follow:

Pheasant No. 1, a cock, was fed 15 grains of the poisoned oats in the forenoon of the first day, 25 grains in the afternoon, and 60 grains on the morning of the next day. All of this it ate readily. Although it showed no effect whatsoever of the poisoning, at the time or later, it nevertheless refused to eat the oats on the third day and continued to reject it when mixed with the regular scratch food.

Pheasant No. 2, a hen, ate 50 grains of the poisoned oats in the forenoon without noticeable effect. In the afternoon the bird was fed 75 grains more. At first it ate none of this but later consumed about three-fourths of it. No other food was given her during the day. The next morning the bird was released, apparently in the best of physical condition.

Pheasant No. 3, a cock, was confined for 24 hours in the experimental pen without any food. At 11 a.m. it was given 100 grains of the poisoned oats. This it ate quickly. There were no noticeable injurious effects.

Pheasant No. 4, a cock, was given as a morning feed 150 grains of poisoned oats, all of which it ate readily and did not appear to suffer in the least from the effects of the strychnine.

From these experiments it would appear that this valuable

game bird is not likely to be much reduced in numbers, if at all, as a result of the poisoning campaigns conducted against the Columbia ground squirrels of eastern Washington. There should be less likelihood of Chinese pheasants being effected by poisoning operations in the "sage-rat" districts of central Washington, since in these operations there is less strychnine used per given quantity of oats than in the formula for Columbia ground squirrel baits.

THEO. H. SCHEFFER
Assistant Biologist.

MEMORANDUM REGARDING DANGER OF QUAIL DESTRUCTION
IN POISONING OPERATIONS AGAINST RODENTS

July 15, 1919

Gallinaceous birds as a group had been known to possess a certain immunity to strychnine poisoning, but little definite information regarding its effect on quail in particular was available until within the last few years. Experiments conducted by a representative of the Biological Survey in California in 1918 established definitely the fact that barley poisoned according to the Survey's standard ground-squirrel formula in use there had no material effect on the abundance of the valley quail under natural conditions. Quail were plentiful and remained so in areas that were heavily poisoned and in which the poisoned grain was renewed every two or three days as it disappeared. Ground squirrels were exterminated but not a single dead quail was found; neither were any observed that manifested symptoms of strychnine poisoning. Specimens subsequently shot showed that quail had been eating the barley, though to a limited extent.

Experiments with captive birds fed on the standard ground-squirrel bait (1 to 16) showed that valley quail might eat it extensively with no deleterious effects. One adult valley quail consumed 125 kernels of poisoned barley in a period of 24 hours with no trace of ill effects. Thus, without injury to itself, this bird had eaten enough strychnine to kill 12 ground squirrels, each three or more times greater in bulk than the bird. When it is considered that ordinarily strychnine is toxic in inverse ratio to the bulk of the animals taking it, the comparative immunity of the valley quail becomes apparent. A limited number of similar experiments with mountain quail and a bobwhite gave like results.

In this connection it will be well to call attention to experiments conducted by the Chief Game Guardian, Saskatchewan, Canada, where it was demonstrated that a prairie chicken ate a quantity of poisoned grain sufficient to kill 100 ground squirrels without experiencing any ill effects.

(Signed) E. W. NELSON
Chief of Bureau.

EXTRACT FROM THE REPORT OF THE CHIEF GAME GUARDIAN
PROVINCE OF SASKATCHEWAN, CANADA, 1918.

The Effect Of Gopher Poison On Prairie Chickens

During the past two or three years the Game Branch has been conducting investigations with a view to obtaining information relative to the scarcity of prairie chickens. A summary of these investigations may be found in the annual reports of the Game Branch for 1915 and 1916, copies of which may be secured upon request.

In conducting these investigations it was found that the majority of correspondents were of the opinion that the indiscriminate distribution of poisoned grain for the destruction of gophers was largely responsible for the scarcity of prairie chickens. This opinion was also shared by nearly all sportsmen, and newspaper articles offering this as an explanation for the scarcity were quite common.

In the light of actual facts the department could not accept this as the principal cause for the remarkable change in the prairie chicken situation, but in justice to those who held this view, it was decided to probe the matter further. Consequently, arrangements were made with R. H. Carter, of Fort Qu'Appelle, to secure a number of live prairie chickens. Mr. Carter employed a half-breed to do this work, and after considerable difficulty eight birds were caught. On arrival at Regina two of the birds were dead and two more died the following day. The four remaining birds were placed in separate cages and fed good, clean grain for the first two days. Drinking water was placed before them all the time. In the meantime arrangements were made with Doctor Charleton, Provincial Bacteriologist, to have one of his staff prepare poisoned grain exactly as recommended by the Government for the destruction of gophers. ****

Before feeding the poisoned grain, a prominent medical man, who had been informed of the nature of the experiment, ventured the opinion that five grains of the poisoned wheat would be sufficient to kill each chicken. Basing our actions on this opinion it was deemed advisable to feed the birds rather sparingly at the start. Three birds were used in the experiment, the fourth being kept in reserve in case of accident. Birds Nos. 1 and 2 were fed almost equal quantities of poisoned grain, while Bird No. 3, after the first morning, was fed nothing but good grain and held in reserve with Bird No. 4.

The following table is a record of the poisoned grain fed to Bird No. 1, and to all intents and purposes is similar to that of Bird No. 2.

Date	Time	No. of grains of poisoned wheat	Result
May 1	:5:30 p.m.	...	:All food removed, cage cleaned, : fresh water and gravel supplied.
May 2	:9:45 a.m.	5	:All grain consumed.
2	:1:30 p.m.	25	:
2	:2:10 p.m.	45	:No bad effects.
2	:2:45 p.m.	350	:
3	:.....	All it would eat	:No bad effects.
4	:9:00 a.m.	350	:All grain consumed. No bad effects.
4	:1:00 p.m.	350	:
4	:3:00 p.m.	350 (forced)	:Stopped feeding last portion on ac-
4	:3:30 p.m.	150 (forced)	: count of bird showing signs of : collapse due to fright caused by : forcing feed and handling. Recover-
			: ed almost immediately when placed : back in cage.
May 5	:.....	All it would eat	:No bad effects.

The result of this experiment would indicate that prairie chickens have some power of resisting the poisonous effect of strychnine, and we are forced to the conclusion that poisoned grain as used by farmers for the destruction of gophers does not under prevailing conditions cause the death of prairie chickens.

To make doubly sure that the poison used in this experiment was of standard strength, I secured three live gophers and fed the mixture to them, giving 15 grains to gopher No. 1, 20 grains to gopher No. 2, and 25 grains to No. 3. After placing the grain in the cages I had occasion to leave the room for a short time, and upon my return gophers Nos. 2 and 3 were dead and No. 1 died shortly after. Therefore, while it took but 15 grains to kill a gopher, prairie chicken No. 1 consumed in one day sufficient poisoned grain to kill 100 gophers, and did not show the slightest effect of poisoning. After the experiment, I gave the prairie chickens to a local poultry fancier, and they remained in good health for several weeks but eventually they died. Strange to relate the prairie chicken which consumed the largest amount of poisoned grain was the last bird to die. I am of the opinion that all birds of the gallinaceous order, which includes prairie chickens, grouse, pheasants and the domestic hen, have some power of resisting the effects of poison, but what that power is, I must leave for the man of science to determine.

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United States Department of Agriculture
Bureau of Biological Survey
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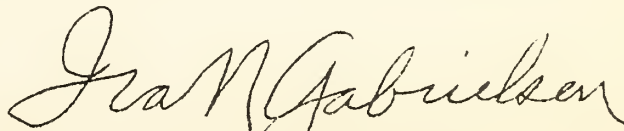
THE EFFECT OF POISONS USED IN RODENT CONTROL ON
GROUSE, PHEASANTS, AND QUAIL

Rodent control is essential to the welfare of western agriculture just as spraying for insect control is an essential part of the operations of the eastern orchardist. These noxious forms of animal life exact a heavy annual toll from the rancher, farmer, orchardist, truck gardener and others engaged in agricultural pursuits throughout the country, and the need for control measures against harmful rodent and insect life becomes apparent.

In many areas of the West where it becomes necessary to use poison-grain baits for the control of injurious rodents we also find the home and habitat of many of our useful and interesting wildlife forms, including the upland game-bird species - grouse, pheasants, and quail. Since the functions of the Biological Survey embrace the field of conservation and encouragement of beneficial and harmless wildlife species as well as reasonable control of the economically injurious forms, it is obvious that the Bureau would neither recommend nor practice methods of control that would endanger the life or welfare of our game birds and other beneficial fauna.

For rodent control operations steam-crushed oats, treated with strychnine, have constituted the main and most effective bait. Some apprehension has been expressed by people interested in conserving our game birds concerning the use of strychnine-treated grain for rodent control in areas where grouse, pheasants, and quail are present. There have also been misleading statements circulated by some, alleging heavy mortality among these game species from eating strychnine-poisoned baits exposed for rodent control. Many of these allegations have been checked, experiments have been conducted, and observations made to determine the effect, if any on grouse, pheasants, and quail, of strychnine grain bait exposed for rodent control. Reports are attached on such investigations made by the Chief Game Guardian of the Province of Saskatchewan, Canada, and in this country by the Associated Sportsmen's Clubs of California, and by the Biological Survey.

These experiments have demonstrated that gallinaceous birds, which include the various species of grouse, pheasants, and quail, as well as mature domestic chickens, possess a relative immunity from strychnine poisoning, and that these birds are not likely to be harmfully affected by eating strychnine-poisoned grain baits mixed in the strychnine-grain proportions recommended by the Biological Survey, and now commonly used in the United States.


Ira N. Gabrielson,
Chief.

RECORDS OF POISON EXPERIMENTS IN DETERMINING THE EFFECTS OF GROUND
SQUIRREL POISONS ON CALIFORNIA VALLEY QUAIL AS CONDUCTED BY THE
ASSOCIATED SPORTSMEN'S CLUBS OF CALIFORNIA IN COOPERATION WITH
THE UNITED STATES BIOLOGICAL SURVEY AND THE CALIFORNIA FISH
AND GAME COMMISSION

September, 1925

For some time complaints have been made to those in the Western States conducting operations with poisoned grain against ground squirrels and other field rodents to the effect that quail are being greatly reduced in number through the distribution of this grain. Several tests had been made by the Biological Survey in different States showing that oats and barley poisoned with strychnine in accordance with its standard formulas would not kill quail, pheasants, or grouse. The United States Public Health Service has made similar tests and reached the same conclusion. Other poisons, such as phosphorus or arsenic, however, which are used to a limited extent in some commercial poisons and by individual ranchers, had not been tested. Investigations had been made and phosphorus placed under suspicion.

The Associated Sportsmen's Clubs of California became interested in the problem of the reduction in the number of quail and arranged to secure the quail for use in experiments with poisons through the State Fish and Game Commission, inviting the Commission and the Biological Survey to cooperate with them in conducting the tests. We were glad to take advantage of this opportunity to make the much desired tests. Representatives of the three organizations were present to observe the results. The members of the Associated Sportsmen's Clubs of California are specially to be commended for the faithful manner in which they have kept some member present to watch the pens both day and night, many sacrificing valuable time and business to keep their watch.

Representatives of the Survey were present during the day to attend to the feeding of the poisons and to watch and record results. A representative of the Fish and Game Commission was present, assisting with suggestions and noting results.

Dr. Frank Kolos, a member of the Associated Sportsmen's Clubs, tested the poisoned grains used and made examinations of the birds that died. George P. Gray, in charge of the Chemical Division of the State Department of Agriculture, cooperated by determining the quantity of poison carried by 100 kernels of the various poisoned grain mixtures used in the tests.

Locality of Experiments

J. P. Cuenin and E. R. Kaufman, representatives of the Associated Sportsmen's Clubs, arranged with John McLaren, superintendent of the Golden Gate Park, San Francisco, for space on the park grounds, and had seven pens built for the birds. Four of these were subdivided into four compartments each for individual birds. The larger pens were for reserve birds. For a few days after arrival the birds, which were brought in from the Sacramento Valley, suffered from the cooler temperature, some dying as a result. The weather soon became warmer and the birds were in good condition most of the time covered by the experiments. A few bad days occurred at the start and a few also at the end of the experiments.

Grains Used in Poisoning Squirrels

The grain recommended by the United States Biological Survey for use against the California "digger" ground squirrel is whole re-cleaned barley, and for use against the Oregon ground squirrel in the northeastern part of the State is whole oats. These grains have been generally used by those in charge of rodent control operations in the different counties. In a few cases wheat and hulled barley are used. In other States oats or rolled oats are chiefly used against field rodent pests.

Poisons Used in Rodent Control

The poison recommended and generally used in operations against field rodents is strychnine alkaloid. Strychnine sulphate is now rarely used. To a limited extent phosphorus, arsenic, and cyanide have been and are used for this purpose.

Distribution of Poisoned Grain

Poisoned grain bait used in controlling ground squirrels is usually well scattered about the burrows of the animals, each bait averaging about a tablespoonful. With grains of average quality, in a tablespoonful of wheat there would be about 400 kernels, of hulled barley about the same number, of whole barley about 350, of oat grouts about 680 and of whole oats about 300. It was found that the squirrels usually cleaned up most of these baits within two days and where infestation is heavy, within a few hours.

Feeding Capacity of Quail and Choice of Grains

Whole Barley.--Four quail kept in separate compartments were given 50, 100, 150, and 200 kernels of whole barley, respectively, without other feed, during a period of 24 hours. The bird given the 100 kernels ate 38 of them, but the others did not take a single kernel.

Other birds had whole barley together with other feed before them for several days and did not eat any.

Hulled Barley.--Two quail kept in separate compartments were given 50 and 100 kernels of hulled barley, respectively, during a period of 24 hours. The one fed the 50 kernels ate all of them, a few at a time, within 3 hours, but the other did not touch any of the grain given to it. They did not appear to relish the hulled barley, though they apparently preferred it to the whole barley.

Whole Oats.--One quail was fed 50 whole dry oat kernels, and during a period of 24 hours hulled and ate 15 of them. Oats soaked in water for a few minutes and then fed along with dry oats were eaten more readily than the dry oats. This was tried on several quail. Rolled oats were eaten more readily than the whole oats.

Hulled Oats, or Oat Groats.--Hulled oats were greedily eaten by the quail. A capacity test run showed that 250 kernels constituted the maximum quantity taken in 24 hours; 200 comprised the average daily feed.

Wheat.--Wheat was readily eaten by the quail. Capacity tests made with several of the birds showed that 150 kernels constituted about the maximum for a period of 24 hours. The average feed at any one time was 50 kernels of average size wheat, although considerably more grain might be placed before them.

When the quail were given a mixture containing all these grains it was observed that they would at once pick out the oat groats and wheat, not touching the other grain as long as these two grains were present. When these were consumed they would take the others in the following order: Hulled barley, oats, and whole barley. They had to be starved into eating the latter grains. In order to get a real test of the quantity of strychnine a quail could take we had to use poisoned wheat.

Record of Poison Tests on Quail*

Pen No. 1

Compartment No. 1.--Two young birds, male and female, were fed, at 10 a.m. on the 13th of the month, 50 kernels of poisoned whole barley of Standard 1-16 (1 ounce of strychnine to 16 quarts of grain) carrying 0.08 grain strychnine. By 10:30 a.m. on the 14th they had taken 22 kernels, and by 4 p.m. of the same day the remainder. They were then given some clean wheat, which they immediately ate. On the 15th they were again given clean grain. At 4:20 p.m. on the 16th, 200 kernels of poisoned whole barley, 1 to 8, carrying 0.56 grain strychnine were fed. Very little of it was eaten until the forenoon of the 17th, when hunger forced the birds to eat it a little at a time. By 5 p.m. all of the grain had been eaten. When released on the 25th the birds showed no ill effects from the poison.

* In addition to the grains fed, all birds were given some lettuce and fresh water daily.

Compartment No. 2.--A young male and a female, the latter droopy with ruffled feathers indicating that it was sick with a cold, at 10 a.m. on the 13th were given 50 kernels of poisoned whole barley, (1 to 8), carry 0.14 grain strychnine. On the 14th at 10:30 a.m., 37 kernels had been eaten, and by 3 p.m. all were consumed. The female gradually grew worse during the day and died in the night. Doctor Kolos, who examined the bird, reported death was due to cold. The male showed no ill effects from the poison.

Compartment No. 3.--An adult female was fed at 10 a.m. on the 14th, 100 kernels of commercial poisoned wheat (1 to 12), carrying 0.158 grain of strychnine. By 5 p.m. about half was consumed, and by 9 a.m. on the following morning all had been taken, at which time the bird was given a little clean wheat. At 10 a.m. on the 18th, she was again given 100 kernels of the same grain which were all eaten by 2:30 p.m., after which she was given clean grain, and showed no ill effects by the 25th.

Compartment No. 4.--One bird was fed clean grains as a check until the 25th, when it was taken to Berkeley and fed for three days, beginning on the 27th, at 8 a.m. and again at 4 p.m., 10 kernels of a county poisoned wheat (1 to 12) and 40 kernels of clean wheat, and then for two more days, at the same hours, 15 kernels of the poisoned wheat and 50 kernels of clean wheat. The bird showed no ill effects from the poison.

Pen No. 4

Compartment No. 1.--An adult male and a female were fed on the 13th at 2 p.m. a commercial poisoned mixture (1 to 12), consisting of 50 kernels of whole barley, 50 kernels of wheat, and 5 raisins and carrying 0.16 grain of strychnine. The female was observed to eat 38 kernels of wheat during the first half hour, and at the end of an hour both of them had eaten the wheat, but no barley or raisins were touched that day. At 10:30 a.m. on the following day 19 kernels of barley and two raisins were taken. The male bird was then removed to another compartment, and the female was given 100 kernels of wheat from the same commercial poison, which she had all eaten at 3 p.m. On the next day she was given 150 kernels of wheat of the same poison, which she ate during the day. On the 16th and thereafter she was fed clean grain, and showed no ill effects by the 25th. In the three days she had taken about 1/2 grain of strychnine, a quantity sufficient to kill 20 squirrels.

Compartment No. 2.--Bird fed clean grain only.

Compartment No. 3.--An adult male was fed on the 15th at 10:30 a.m. 150 kernels of a county poisoned wheat carrying 0.192 grain of strychnine, no other feed being present. By 10 a.m. on the 16th it had eaten only two kernels; when 50 kernels of clean wheat were given

the bird it readily consumed them, indicating a marked discrimination against the poisoned grain. By 4 p.m. the bird had eaten 68 more kernels of the poisoned wheat. The next day it ate 70 more, and by the 18th had eaten all of it, being forced by hunger to do so. It experienced no apparent ill effects by the 25th.

Compartment No. 4.--An adult male was fed on the 16th at 10 a.m., 150 kernels of the same poisoned wheat that was given to the bird in compartments No. 3. This bird did not delay so long in eating the grain, having taken all of it by 5 p.m. On the next and subsequent days to the 25th it was fed clean grain and showed no ill effects of the poison.

Pen No. 3

Compartment No. 1.--An adult male on the 16th at 3 p.m. was fed 25 kernels of oats and 5 kernels of wheat, carrying 0.2 grain of phosphorus. It hesitated somewhat about eating the oats, but being hungry finally ate all including the hulls. By 3:45 p.m. it began to show symptoms of sickness; at 4:20 it became drowsy, opening and closing eyes, appearing less and less active until 5 p.m. when it turned a somersault forward. It lay quiet for three minutes, then had a severe convulsion and died a minute later at 5:04 p.m.; 0.20 grain of phosphorus killed the bird in about 1-1/2 hours from the time it ate the oats.

Compartment No. 2.--An adult female on the 16th at 3 p.m. was fed 25 kernels of wheat carrying 0.144 grain of phosphorus. The bird picked up and dropped the kernels many times before swallowing a kernel. By 4 p.m. it had eaten only 8 kernels; and no more had been taken by 5 p.m., when the remaining 17 were removed. It began to show effects of the poison at 4:45 p.m., and gradually grew quieter and sleepier until 6 p.m.; when it had a convulsion and died at 6:05 p.m.; 0.046 grain of phosphorus thus killed the bird in about 2-1/2 hours.

Compartment No. 3.--An adult male on the 17th, at 10:15 a.m., was fed 5 kernels of oats, carrying 0.04 grain of phosphorus. It finished eating them by 11 a.m., and became sick at noon. The first light convulsion occurred at 1:30 p.m., and was followed by several others. The bird kept stretching its neck and twisting its head from side to side, and died at 2:15 p.m.; 0.04 grain of phosphorus killed the quail in about 3-1/2 hours.

On the 18th another quail, an adult female, was put in this compartment and was given 100 kernels of oat groats carrying about 0.025 grain of Swartze's white arsenic. All the grain was eaten in a few minutes. The bird began to show drowsiness at about 12 m., which gradually increased until 1:30 p.m., when it sat down. It remained in this position until 2:20 p.m., when it fell over on its side and twisted its head about similar to the birds given phosphorus. It died at 2:36 p.m.;

0.25 grain of arsenic killed it in about 4-1/2 hours. Arsenic is thus seen to be not so toxic to quail as is phosphorus.

Compartment No. 4.--An adult male on the 16th, at 3:30 p.m., was fed 50 kernels of wheat and 50 kernels of barley from a poisoned grain manufactured commercially. It was old material, and the active poison is not known. At 3:30 p.m. on the following day with no other grain present the bird had not eaten any of it. This was then removed and 50 kernels of the wheat with some clean wheat was fed. The clean grain was eaten on the 18th and 19th, but very little of the poisoned wheat was taken. On the 20th at 3 p.m., 150 kernels of wheat from a fresh supply of this same commercial poison, which was labeled strychnine as the active poison, was given with no clean grain present. About half of these were consumed by 4 p.m., and the remainder by 2 p.m. on the following day. The bird shows no ill effects.

Pen No. 2

Compartment No. 1.--A young female on the 13th at 9:45 a.m. was fed 25 kernels of hulled barley, carrying about 0.02 grain of thallium sulphate. No other grain was present. By 11 a.m. on the following day only one kernel was taken. This grain was then removed and the bird given clean grain. On the 15th at 4:30 p.m. the bird was given 50 kernels of oat groats, carrying 0.138 grain of thallium which it ate at once. It was fed clean grain on the 16th and 17th. By 3 p.m. on the 18th it showed no ill effects so it was given 100 kernels more of the same poison, which it had eaten by 5 p.m. On the following morning at 6 a.m. the bird was active but was extending its neck and gasping for breath at fairly regular intervals--the usual symptom of thallium poisoning. It did not eat during the day and gradually grew weaker without any apparent pain, and died at 3:25 p.m.

Compartment No. 2.--A young male, refused to eat the poisoned hulled barley fed to it similar to the bird in Compartment 1. On the 16th, at 3:45 p.m., it was given 75 kernels of the oat groats preparation, carrying 0.207 grain of thallium sulphate, which it ate within 45 minutes. On the 18th and 19th the bird was drowsy and did not eat normally, but on the 20th it began to improve and was normal on the following day, and remained so until the 29th. On the 30th a test was begun to determine the accumulative action of thallium sulphate. The bird was given 25 kernels of the oat groats carrying 0.069 grain of thallium sulphate and 75 kernels of clean oat groats at 8 a.m. and like quantities repeated at 4 p.m. of the same day and at 8 a.m. on October 1. It died on October 1 during the night.

Compartment No. 3.--A young female on the 14th at 10:15 a.m. was fed 100 kernels of oat groats, carrying 0.277 grain of thallium sulphate. It had eaten half of the oats by noon and all by 3 p.m.; and was given a little clean grain in the evening, which it ate. Bird was lively at

midnight but quite sick at 6 a.m. It died at 10:30 a.m., about 24 hours from the time it began eating the poison.

Compartment No. 4.--The test given the bird in Compartment No. 3 was repeated with an adult female on the 17th at 4 p.m. The bird ate the poisoned grain at once. It was normal on the 18th. Fed clean grain on the 19th it ate the grain but was less active and not quite normal. At 8 a.m. on the 20th the bird was very sick, dying an hour later. The same quantity of poison as that given the young female in Compartment No. 3 killed this adult female in 65 hours.

Compartment No. 1.--A new bird, an adult male, was put in this compartment and fed 10 kernels of a commercial wheat preparation, carrying 0.02 grain of phosphorus, on the 22nd at 3 p.m. It ate the grain at once, and had a convulsion at 7:45 p.m., dying at 8:15 p.m.

These tests corroborate previous experiments made with strychnine on quail. The nine different birds fed poisoned grain ate from 2 to 150 kernels of wheat a day, and as much as 300 kernels during three consecutive days with and without clean grain and were not affected; also birds fed 50 kernels of wheat morning and evening, 10 of which were poisoned, for 5 consecutive days showed no ill effects.

The experiments have left no doubt about phosphorus, since only five kernels killed a quail in 4-1/2 hours. There is great danger to game birds in poisoning operations even if whole barley is used, for though the tests showed they do not take barley or whole oats readily, they are likely to pick up from 5 to 20 kernels of the grain in many localities, which would be fatal. Phosphorus is very toxic to quail, and its use should be prohibited.

Arsenic and thallium sulphate are less toxic than phosphorus, but as they may have to be used on hulled grain or rolled grain to obtain the most efficient results against ground squirrels, there would be considerable danger to game birds in the distribution of such grains for squirrels or other field rodents. It is believed that phosphorus, arsenic, and thallium should not be used in poisoning operations in which baits would be exposed to any animal other than those against which the control operations are directed. They could be used in rat and field-mouse control where the distribution is confined.

The experiments show also that young quail are not affected any more by strychnine than adults. There is some indication, however, that thallium sulphate may kill the young more quickly than the adults. More tests will have to be made in order to determine definitely this latter point.

Respectfully submitted,

F. E. GARLOUGH
Assistant Biologist.

JOSEPH KEYES
Leader Rodent Control.

AN EXPERIMENT TO DETERMINE THE EFFECT (IF ANY) OF
FEEDING STRYCHNINE POISONED GRAIN TO GROUSE

January, 1923.

Tuesday, January 9, 1923.--Four grouse were received from Powder River County from a rancher near Ashland, Mont., on a tributary of the Tongue River. There he caught these birds with a figure-4 trap. He shipped them on January 6 and they arrived here January 9 at noon. In the crate were supplied corn and wheat. At 4:30 p.m., while being transferred to a larger coop, one bird escaped and flew into a glass door, breaking the glass and continuing its flight into the country, apparently unharmed. The birds appeared to be sharp-tailed grouse (*Pediocetes phasianellus campestris*) and were in good condition. They were fed wheat and oats and given water and left for the night in a pen 6 by 3 feet in size.

Wednesday, January 10.--The pen was divided into three sections with a bird in each section. Bird No. 1, apparently a cock and seemingly older than the other two, was used as the "check". This bird was by far the most restless and fought the screen a good share of the time. No. 2 was somewhat restless, while No. 3 was quite content and did not fight the screen. All food was removed in the morning. At 2 p.m. each bird was given 50 kernels of clean wheat and oats and 6 kernels of corn. The corn and wheat were eaten at once. They did not relish the oats. At 4 p.m. Nos. 2 and 3 had eaten all the oats. The birds seemed to be quite tame. They were not fed again until next day.

Thursday, January 11.--The birds were not given any feed in the morning. No. 1 had oats left. At 4 p.m. No. 1 was fed 150 grains of clean oats. No. 2 was fed 150 grains of Richardson's ground squirrel bait and No. 3 was given 300 grains of prairie-dog bait. These quantities are equal to the quantities of bait recommended for these rodents and are equivalent to a teaspoonful and a tablespoonful respectively.

Bird No. 2 ate the 150 oats at once, readily. Given 150 additional kernels, it ate them at intervals. At 4:10 most of these kernels were eaten and 150 more were given. By 4:30 the oats were all eaten (450 kernels).

Bird No. 3 did not attack the oats so greedily and ate about one-half of the 300 kernels at first. It ate the last half at intervals, apparently not relishing them. At 4:30 p.m. No. 3 had 65 grains left. At 5 p.m., all birds seemed to be normal, and if the poisoned grain fed them had any harmful effect it was not apparent.

Friday, January 12.--No. 1, the check bird, was fed 200 clean oats in addition to some remaining from the day before. This bird did not seem to care for oats and spent most of its time fighting the screen in attempts to get out.

No. 2 was given 150 more of poisoned grain at 8:30 a.m. At 1:30 p.m. the bird had eaten only 14 of these. The remainder was thrown out, and a fresh bait of 150 kernels was given.

No. 3 still had the 65 remaining oats. These were thrown out and a fresh bait of 300 poisoned oats given at 8:30 a.m. By 1:30 p.m. No. 3 had eaten 35 grains; the rest of the bait was thrown out and a new bait of 300 fed.

The birds seemed to be hungry but did not like the oats. They were all active and showed no ill effects of eating poison.

Saturday, January 13.--At 9 a.m. No. 1 still had oats and ate few or none. No. 2 had 60 oats left and was not fed a new bait; by 5 p.m. it had eaten these and was given 36 more. At 9 a.m. No. 3 had 225 left. These were thrown out and a new bait of 100 grains given; at 5 p.m. it had 30 of the 100 left and was given 35 more.

The birds were left for the day. They were apparently unaffected by eating the poisoned oats.

Sunday, January 14.--All birds are active and hungry at 8:30 a.m. The check bird had 150 oats left. No. 2 had 22 left. No. 3 had 65 grains left and had therefore eaten none since the day before.

It was decided that the birds could not be killed by being fed poisoned oats, they having had practically all they wanted since the experiment started. The oats were all removed and each given 3 tablespoonfuls of clean wheat. The wheat runs 550 grains to the spoonful. They started eating the wheat greedily.

No. 1 ate the least. No. 2 ate more and No. 3 the most, about one-third of it. Their appetites seemed to be satisfied with these quantities. Although No. 1, the check bird, was the most restless, it would take grain out of the hand. No. 2 ate grain readily out of the hand.

Monday, January 15.--At 8:30 a.m. No. 1 had eaten three-fourths of the wheat and by 11 a.m. had only a teaspoonful left. No. 2 had 30 kernels of wheat left, which were eaten within a few minutes. No. 3 had 200 kernels left, which it cleaned up by 11 a.m. The above was all clean wheat.

It was believed that the grouse did not relish oats, so in order

to get them to take more poison it was decided to try them on some strychnine poisoned wheat, which was prepared at about the same strength as for prairie-dog poison.

At 2 p.m. No. 2 was given one-half tablespoonful of poisoned wheat, which it ate greedily, most of it out of the hand. It was given the other half at once and ate about one-half of it rapidly and then seemed satisfied and rested contentedly.

No. 3 was fed one-half tablespoonful of the same wheat. It ate one-half of it but not greedily. Seemed satisfied and contented. The wheat runs 550 grains per tablespoonful. The birds showed no symptoms of poisoning and were left for the day.

Tuesday, January 16.--At 9 a.m. No. 1 was fed a tablespoonful of clean wheat, which it ate greedily at once. At noon it ate another spoonful rapidly, at 3:30 another, and at 4:30 another, making 4 tablespoonfuls in all, or about 2,200 kernels.

At noon the 150 kernels of wheat remaining from the previous day's feed were removed from bird No. 2 and another tablespoonful of poisoned wheat was given.

No. 3 had eaten all of the previous day's bait by noon and was fed another tablespoonful.

Wednesday, January 17.--At 9 a.m. No. 1 was given a tablespoonful of clean wheat, which it ate at once. It was given a few clean oats but did not eat them. Another tablespoonful of clean wheat was given. No. 2 had one-half of the last bait left. This was thrown out and one-half tablespoonful of new poisoned wheat given. The bird did not care for this.

No. 2 had two-thirds of the last bait left. This was thrown out and another one-half spoonful given. The birds seemed to get "tired" of the poisoned wheat, while the check bird consumed large quantities of clean wheat.

Thursday, January 18.--At 9 a.m. No. 1 bird had no wheat left. It was given a tablespoonful of poisoned wheat of which he ate about one-half and then started "playing" with the remainder, picking up the kernels and casting them aside. The poisoned wheat was removed and replaced with a tablespoonful of clean wheat. This he went at greedily, eating all of it at once. Another tablespoonful was given. By 3:30 p.m. it had eaten most of this feed and was given the third tablespoonful of clean wheat. It ate most of this in a short time and was given a fourth tablespoonful of which it ate but very little up to 4 o'clock.

Bird No. 2 had practically all of the previous day's last bait left at 9 a.m. This was thrown out and the bird was given a new feed of a tablespoonful of poisoned wheat. It probably ate a few kernels but picked up and ejected quite a number. The poisoned wheat was removed, and the bird was fed a tablespoonful of clean wheat. This was eaten greedily. Another tablespoonful was given which was gone by 3:30. It ate all of a third tablespoonful and was given a fourth, most of which was eaten by 5 o'clock.

Bird No. 3 at 9 o'clock had 50 kernels of yesterday's last feed left. This was thrown out and it was given a fresh tablespoonful of poisoned wheat just as was done with Nos. 1 and 2. It ate but a few kernels. All poisoned grain was removed and a tablespoonful of clean wheat given. This was eaten at once followed by a second and then a third tablespoonful at 3:30. The second and most of the third spoonfuls were eaten readily and a fourth tablespoonful was fed of which she ate but little.

It will be noted that all three of these birds were fed exactly alike. The way they reacted toward the poisoned wheat as compared with the clean wheat indicates that there is something objectionable to the former. Although the poisoned wheat is dull and rather musty looking, on account of treatment, it is believed that the bitter taste of the strychnine is the cause for objection shown by the birds.

Friday, January 19.--At 9 a.m. bird No. 1 had one-half teaspoonful of wheat left, bird No. 2 had eaten all, and bird No. 3 had one-half teaspoonful left. The experiment being completed, the birds, apparently in the best of condition, were removed to a large outdoor inclosure containing some Chinese pheasants and doves. They were under the care of the poultry department and were fed ordinary mixed grain along with the pheasants and doves.

Mr. Otto Stephi, Junior Biologist, was in charge of this experiment.

(Signed) A. E. OMAN
Biological Assistant
District Leader.

EXPERIMENTS TO DETERMINE EFFECT OF POISONED GRAIN ON
CHINESE PHEASANTS

January, 1922

With a view to determining the effect on the introduced Chinese pheasant of poisoned grain distributed for ground squirrels, a number of tests were made with birds secured from the King County game farm, at Snoqualmie, Wash. Clean, whole oats treated with poisoned flour paste were used throughout the experiments. The grain was prepared according to the formula and directions followed in mixing poisoned bait for the Columbia ground squirrel, which contains one ounce of strychnine alkaloid to every 12 quarts of oats.

The pheasants were undergrown birds about five or six months old. On arrival at the Experiment Station they were confined in a netting inclosure and fed on a mixture of grains such as is used for scratch food in the poultry department. Each bird, in turn, was transferred to a smaller coop for trial with the poisoned grain. Fresh water was accessible to them at all times. Results of the experiments follow:

Pheasant No. 1, a cock, was fed 15 grains of the poisoned oats in the forenoon of the first day, 25 grains in the afternoon, and 60 grains on the morning of the next day. All of this it ate readily. Although it showed no effect whatsoever of the poisoning, at the time or later, it nevertheless refused to eat the oats on the third day and continued to reject it when mixed with the regular scratch food.

Pheasant No. 2, a hen, ate 50 grains of the poisoned oats in the forenoon without noticeable effect. In the afternoon the bird was fed 75 grains more. At first it ate none of this but later consumed about three-fourths of it. No other food was given her during the day. The next morning the bird was released, apparently in the best of physical condition.

Pheasant No. 3, a cock, was confined for 24 hours in the experimental pen without any food. At 11 a.m. it was given 100 grains of the poisoned oats. This it ate quickly. There were no noticeable injurious effects.

Pheasant No. 4, a cock, was given as a morning feed 150 grains of poisoned oats, all of which it ate readily and did not appear to suffer in the least from the effects of the strychnine.

From these experiments it would appear that this valuable

game bird is not likely to be much reduced in number, if at all, as a result of the poisoning campaigns conducted against the Columbia ground squirrels of eastern Washington. There should be less likelihood of Chinese pheasants being affected by poisoning operations in the "sage-rat" districts of central Washington, since in these operations there is less strychnine used per given quantity of oats than in the formula for Columbia ground squirrel baits.

THEO. H. SCHEFFER
Assistant Biologist.

MEMORANDUM REGARDING DANGER OF QUAIL DESTRUCTION
IN POISONING OPERATIONS AGAINST RODENTS

July 15, 1919

Gallinaceous birds as a group had been known to possess a certain immunity to strychnine poisoning, but little definite information regarding its effect on quail in particular was available until within the last few years. Experiments conducted by a representative of the Biological Survey in California in 1918 established definitely the fact that barley poisoned according to the Survey's standard ground-squirrel formula in use there had no material effect on the abundance of the valley quail under natural conditions. Quail were plentiful and remained so in areas that were heavily poisoned and in which the poisoned grain was renewed every two or three days as it disappeared. Ground squirrels were exterminated but not a single dead quail was found; neither were any observed that manifested symptoms of strychnine poisoning. Specimens subsequently shot showed that quail had been eating the barley, though to a limited extent.

Experiments with captive birds fed on the standard ground-squirrel bait (1 to 16) showed that valley quail might eat it extensively with no deleterious effects. One adult valley quail consumed 125 kernels of poisoned barley in a period of 24 hours with no trace of ill effects. Thus, without injury to itself, this bird had eaten enough strychnine to kill 12 ground squirrels, each three or more times greater in bulk than the bird. When it is considered that ordinarily strychnine is toxic in inverse ratio to the bulk of the animals taking it, the comparative immunity of the valley quail becomes apparent. A limited number of similar experiments with mountain quail and a bobwhite gave like results.

In this connection it will be well to call attention to experiments conducted by the Chief Game Guardian, Saskatchewan, Canada, where it was demonstrated that a prairie chicken ate a quantity of poisoned grain sufficient to kill 100 ground squirrels without experiencing any ill effects.

(Signed) E. W. NELSON
Chief of Bureau.

EXTRACT FROM THE REPORT OF THE CHIEF GAME GUARDIAN
PROVINCE OF SASKATCHEWAN, CANADA, 1918.

The Effect of Gopher Poison on Prairie Chickens

During the past two or three years the Game Branch has been conducting investigations with a view to obtaining information relative to the scarcity of prairie chickens. A summary of these investigations may be found in the annual reports of the Game Branch for 1915 and 1916, copies of which may be secured upon request.

In conducting these investigations it was found that the majority of correspondents were of the opinion that the indiscriminate distribution of poisoned grain for the destruction of gophers was largely responsible for the scarcity of prairie chickens. This opinion was also shared by nearly all sportsmen, and newspaper articles offering this as an explanation for the scarcity were quite common.

In the light of actual facts the department could not accept this as the principal cause for the remarkable change in the prairie chicken situation, but in justice to those who held this view, it was decided to probe the matter further. Consequently, arrangements were made with R. H. Carter, of Fort Qu'Appelle, to secure a number of live prairie chickens. Mr. Carter employed a half-breed to do this work, and after considerable difficulty eight birds were caught. On arrival at Regina two of the birds were dead, and two more died the following day. The four remaining birds were placed in separate cages and fed good, clean grain for the first two days. Drinking water was placed before them all the time. In the meantime arrangements were made with Doctor Charleton, Provincial Bacteriologist, to have one of his staff prepare poisoned grain exactly as recommended by the Government for the destruction of gophers. ****

Before feeding the poisoned grain, a prominent medical man, who had been informed of the nature of the experiment, ventured the opinion that five grains of the poisoned wheat would be sufficient to kill each chicken. Basing our actions on this opinion it was deemed advisable to feed the birds rather sparingly at the start. Three birds were used in the experiment, the fourth being kept in reserve in case of accident. Birds Nos. 1 and 2 were fed almost equal quantities of poisoned grain, while Bird No. 3, after the first morning, was fed nothing but good grain and held in reserve with Bird No. 4.

The following table is a record of the poisoned grain fed to Bird No. 1, and to all intents and purposes is similar to that of Bird No. 2.

Date	Time	No. of grains of poisoned wheat	Result
May 1	5:30 p.m.	---	All food removed, cage cleaned, fresh water and gravel supplied.
May 2	9:45 a.m.	5	All grain consumed.
2	1:30 p.m.	25	
2	2:10 p.m.	45	No bad effect.
2	2:45 p.m.	350	
3	All it would eat	No bad effects.
4	9:00 a.m.	350	All grain consumed. No bad effects.
4	1:00 p.m.	350	
4	3:00 p.m.	350 (forced)	Stopped feeding last portion on ac- count of bird showing signs of
4	3:30 p.m.	150 (forced)	collapse due to fright caused by forcing feed and handling. Recover- ed almost immediately when placed back in cage.
May 5	All it would eat	No bad effects.

The result of this experiment would indicate that prairie chickens have some power of resisting the poisonous effect of strychnine, and we are forced to the conclusion that poisoned grain as used by farmers for the destruction of gophers does not under prevailing conditions cause the death of prairie chickens.

To make doubly sure that the poison used in this experiment was of standard strength, I secured three live gophers and fed the mixture to them, giving 15 grains to gopher No. 1, 20 grains to gopher No. 2, and 25 grains to No. 3. After placing the grain in the cages I had occasion to leave the room for a short time, and upon my return gophers Nos. 2 and 3 were dead and No. 1 died shortly after. Therefore, while it took but 15 grains to kill a gopher, prairie chicken No. 1 consumed in one day sufficient poisoned grain to kill 100 gophers, and did not show the slightest effect of poisoning. After the experiment, I gave the prairie chickens to a local poultry fancier, and they remained in good health for several weeks but eventually they died. Strange to relate the prairie chicken which consumed the largest amount of poisoned grain was the last bird to die. I am of the opinion that all birds of the gallinaceous order, which includes prairie chickens, grouse, pheasants and the domestic hen, have some power of resisting the effects of poison, but what that power is, I must leave for the man of science to determine.

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